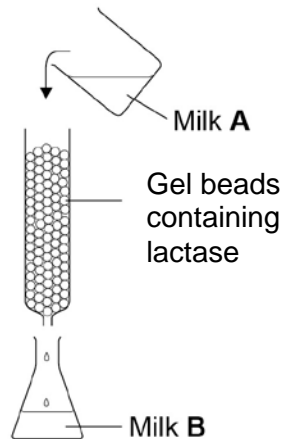


Answer **all** questions in the spaces provided.

0 1

Many humans are unable to digest lactose. A scientist investigated the production of lactose-free milk. He produced gel beads containing the enzyme lactase and placed the beads in a column. He poured milk (Milk **A**) into the column and collected the milk (Milk **B**) after it had moved through the column over the beads. This is shown in **Figure 1**.

Figure 1



0 1

. 1 Milk **A** contains no glucose. Milk **B** contains glucose. Explain why Milk **B** contains glucose.

[1 mark]

0 1

. 2 The enzyme was trapped within the gel beads. Suggest **one** advantage of trapping the enzyme within the gel beads.

[1 mark]

The scientist varied the flow rate of the milk through the column. The effect of flow rate on the concentration of glucose in Milk **B** is shown in **Table 1**.

Table 1

Flow rate of milk through the column / $\text{cm}^3 \text{ minute}^{-1}$	Concentration of glucose in Milk B / arbitrary units
50	45
100	6

0 1 . **3** Explain the difference in the results in **Table 1**.

[1 mark]

0 1 . **4** The gel beads were all similar sizes. Use the formula below to calculate the volume of one of the beads with a 3.0 mm diameter.

[1 mark]

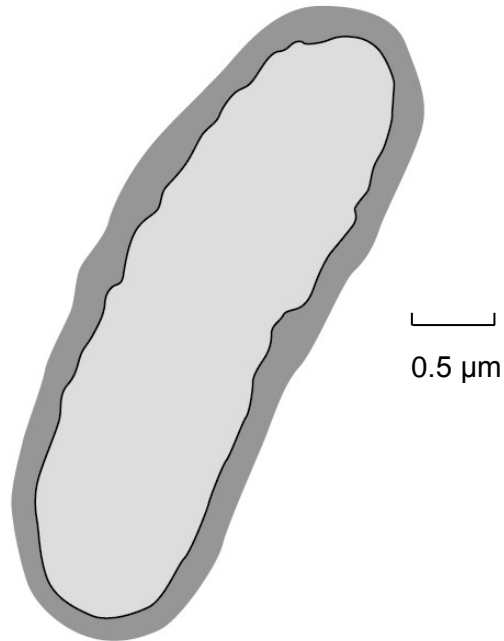
$$\text{Volume of sphere} = \frac{4}{3} \pi r^3$$

$$\text{Volume} = \underline{\hspace{2cm}} \text{ mm}^3$$

0 1 . **5** Galactose has a similar structure to part of the lactose molecule. Explain how galactose inhibits lactase.

[2 marks]

0 2

A bacterium is shown in **Figure 2**.**Figure 2**

0 2

. 1 Calculate the magnification of the image.

[1 mark]

Magnification = _____

0 2

. 2 Complete **Table 2** to show the features of a bacterium and a virus.
Put a tick (✓) in the box if the feature is shown.

[2 marks]

Table 2

Surface	Bacterium	Virus
Cell-surface membrane		
Nucleus		
Cytoplasm		
Capsid		

0 2 . **3** DNA and RNA can be found in bacteria.

Give **two** ways in which the nucleotides in DNA are different from the nucleotides in RNA.

[2 marks]

1 _____

2 _____

5

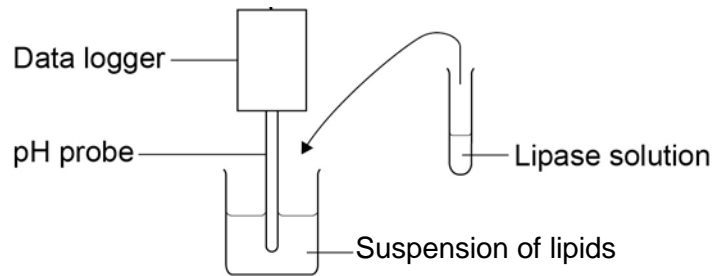
Turn over for the next question

0 3

A student investigated the effect of lipase concentration on the hydrolysis of lipids.

He took a beaker containing a suspension of lipids. He placed a pH probe attached to a data logger into the beaker. After 5 minutes, he added the lipase solution. The data logger recorded the pH. The apparatus used is shown in **Figure 3**.

Figure 3



0 3

. 1

The student did **not** add a buffer to the lipase solution.

Explain why.

[1 mark]

0 3

. 2

Give **two** variables the student would have controlled in this investigation.

[2 marks]

1 _____

2 _____

0 3

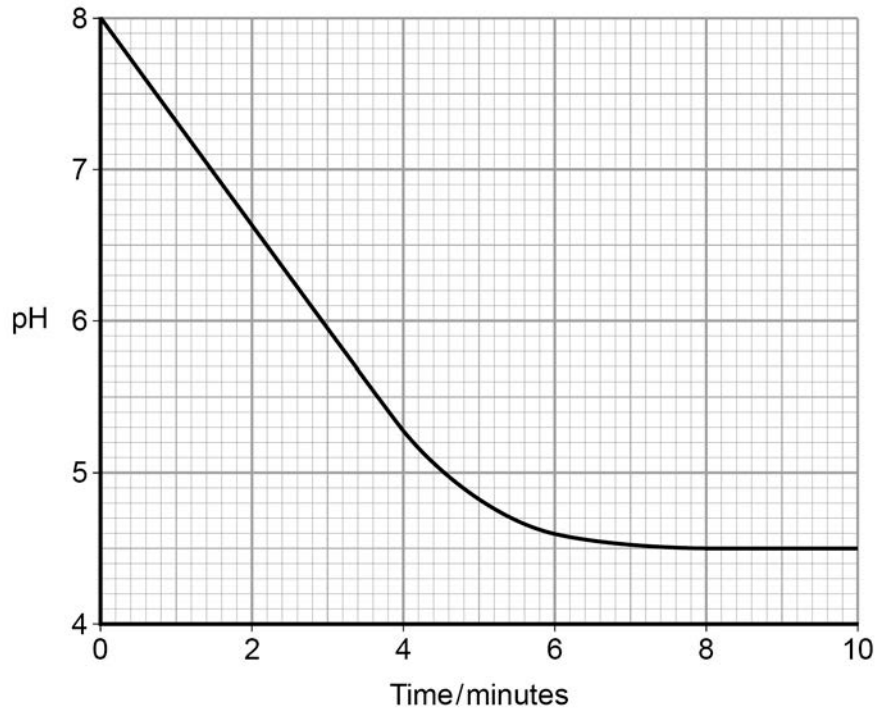
. 3

Give the suitable control for this investigation.

[1 mark]

The data logger recorded the pH. **Figure 4** shows what happened after he added the lipase solution.

Figure 4



0 3 . **4** Draw a tangent on **Figure 4** and use it to calculate the rate of change at 5 minutes.

[2 marks]

Rate of change at 5 minutes = _____ pH minute⁻¹

0 3 . **5** Explain the results shown in **Figure 4**.

[2 marks]

Question 3 continues on the next page

0 3 . 6 The student repeated the experiment with a higher concentration of lipase solution. Describe and explain the results you would expect him to get.

[3 marks]

0 4

In a eukaryotic cell, transcription results in a molecule of pre-mRNA that is modified to produce mRNA. In a prokaryotic cell transcription produces mRNA directly.

0 4 . 1

Explain this difference.

[2 marks]

0 4 . 2

Give **two** differences between the structure of mRNA and the structure of tRNA.

[2 marks]

1 _____

2 _____

4

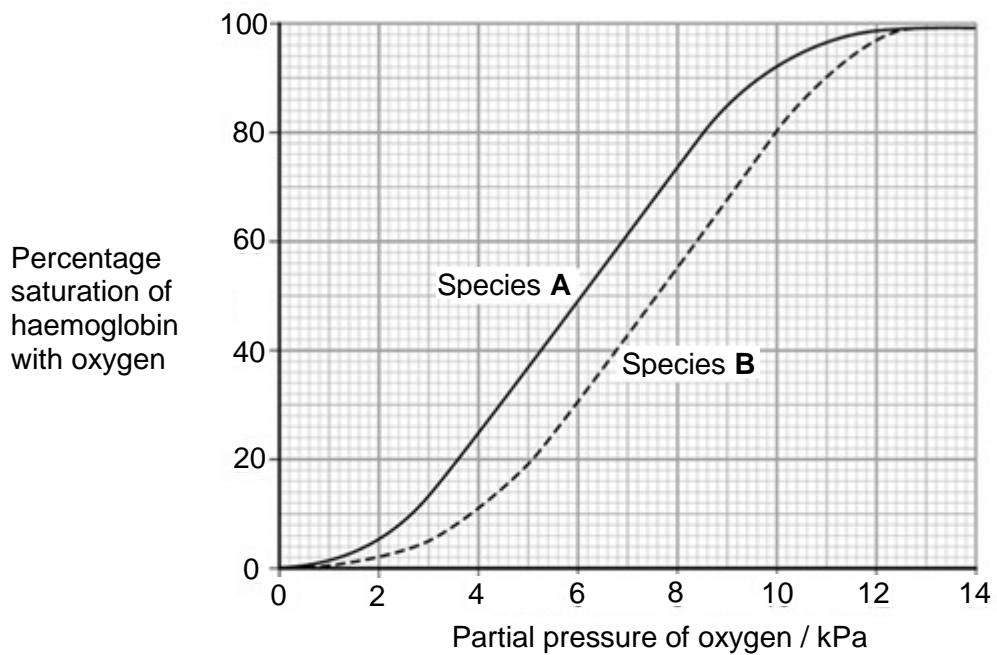
Turn over for the next question

0 5 . **1** Explain **four** ways in which the structure of the aorta is related to its function.

[4 marks]

Figure 5 shows the oxyhaemoglobin dissociation curves for two different species, **A** and **B**.

Figure 5



0 5 . 2

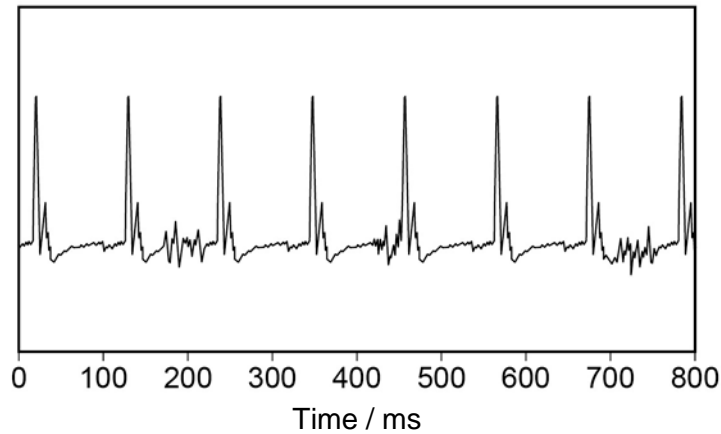
Species **B** is more active than species **A**. Use **Figure 5** to explain how the haemoglobin of species **B** allows a greater level of activity.

[4 marks]

0 5 . 3

An electrocardiogram (ECG) shows the electrical activity of the heart. **Figure 6** shows an ECG for an animal of species **B** at rest. Each large spike represents a contraction of the ventricles.

Figure 6



For species **B**, the mean volume of blood leaving the left ventricle during each contraction is 0.03 cm^3 .

Calculate the mean volume of blood leaving the left ventricle per minute.

[2 marks]

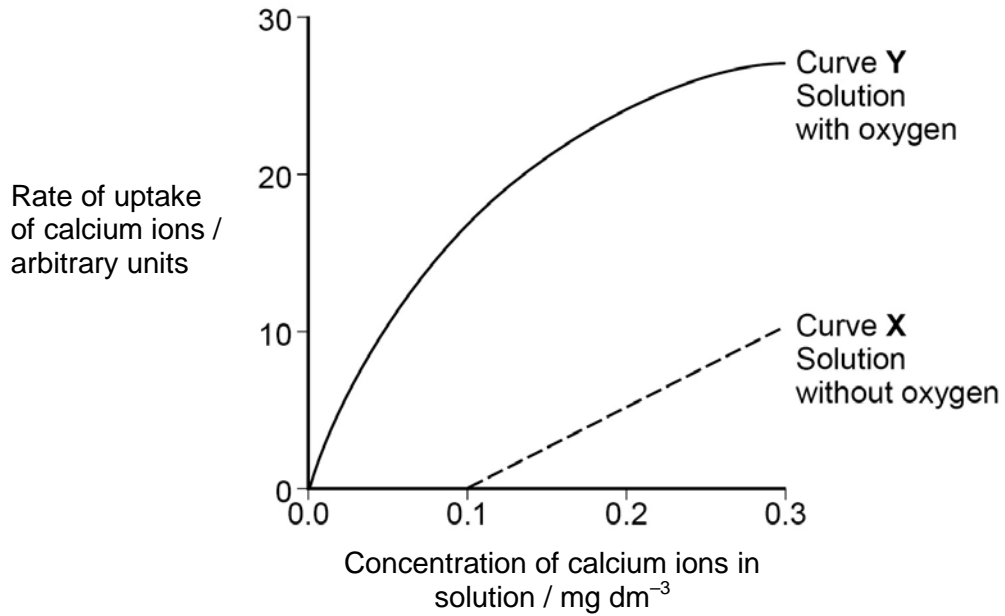
Volume of blood = _____ $\text{cm}^3 \text{ minute}^{-1}$

10

0 6

A scientist placed plant cells in solutions containing different concentrations of calcium ions. She measured the rate of uptake of calcium ions by plant cells. **Figure 7** shows her results.

Figure 7



0 6 . 1

What can you conclude from **Figure 7** about the processes involved in the uptake of calcium ions by these plant cells? Use evidence from **Figure 7** to support your answer.

[5 marks]

06

. 2

Suggest **one** way in which the scientist could have ensured the solutions she used for curve **X** contained **no** oxygen.

[1 mark]

6

Turn over for the next question

0 7 . **1** Name the monomers from which a maltose molecule is made. **[1 mark]**

0 7 . **2** Name the type of chemical bond that joins the **two** monomers to form maltose. **[1 mark]**

A student wanted to produce a dilution series of a maltose solution so he could plot a calibration curve. He had a stock solution of maltose of concentration 0.6 mol dm^{-3} and distilled water. He made a series of dilutions from 0.1 to 0.6 mol dm^{-3} .

0 7 . **3** Complete **Table 3** by giving all headings, units and the concentration of the maltose solution produced. **[2 marks]**

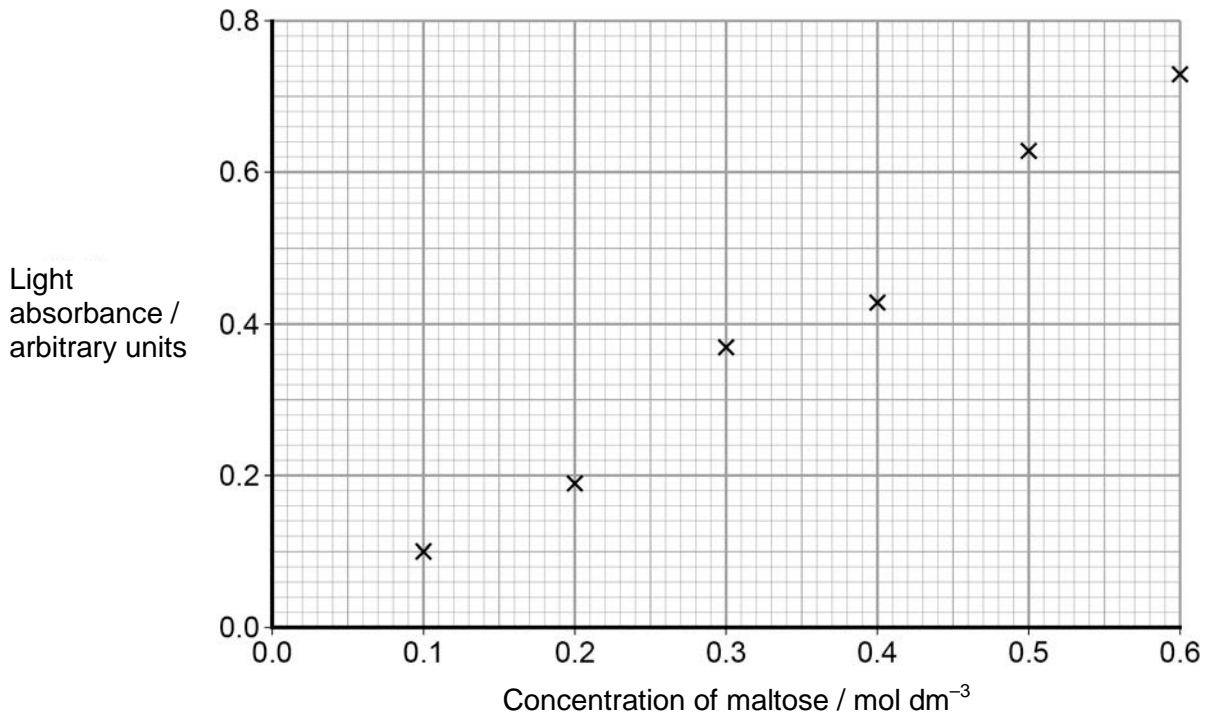
Table 3

Concentration of maltose solution /	Volume of 0.6 mol dm^{-3} maltose solution / cm^3 /
.....	5	10

The student performed the Benedict's test on six maltose solutions ranging from 0.1 mol dm^{-3} to 0.6 mol dm^{-3} . He placed a sample of each solution in a colorimeter and recorded the light absorbance.

His results are shown in **Figure 8**.

Figure 8



0 7 . 4 Explain how you would use **Figure 8** to determine the maltose concentration with a light absorbance of 0.45 arbitrary units.

[2 marks]

0 8

A student investigated the species richness and index of diversity of insects in three different habitats, a barley field, a wheat field and a hedge.

Her results are shown in **Table 4**.

Table 4

Insect species	Number of individuals of each insect species in each habitat		
	Barley field	Wheat field	Hedge
a	32	4	34
b	78	0	12
c	0	126	22
d	0	5	12
e	0	0	8
f	0	0	42
g	0	25	13
h	0	10	12
i	0	0	12
j	42	41	0
Species richness			
Total number of insects (N)			

0 8

. 1

Complete **Table 4** for species richness and the total number of insects of each habitat.

[2 marks]

0 8 . 2 Calculate the index of diversity of the wheat field.

[2 marks]

Use the following formula:

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

where N = total number of organisms

and n = total number of organisms of each species.

0 8 . 3 The index of diversity of the insects was higher in the hedge than in the barley field. Suggest why.

[3 marks]

7

Turn over for the next question

0 9 . **1** Name the process by which bacterial cells divide.

[1 mark]

A microbiologist investigated the ability of different plant oils to kill the bacterium *Listeria monocytogenes*. She cultured the bacteria on agar plates. She obtained the bacteria from a broth culture.

0 9 . **2** Describe **two** aseptic techniques she would have used when transferring a sample of broth culture on to an agar plate. Explain why each was important.

[4 marks]

The microbiologist tested five different plant oils at two different temperatures and determined the minimum concentration of plant oil that killed the *L. monocytogenes*.

Table 5 shows her results.

Table 5

Plant oil	Minimum concentration of plant oil that killed <i>Listeria monocytogenes</i> / percentage	
	4 °C	35 °C
Bay	0.10	0.04
Cinnamon	0.08	0.08
Clove	0.05	0.05
Nutmeg	>1.00	0.05
Thyme	0.02	0.03

0 9 . **3** Which plant oil is least effective at killing *L. monocytogenes* at 35 °C?

[1 mark]

L. monocytogenes is a pathogen of great concern to the food industry, especially in foods stored in refrigeration conditions (4 °C) where, unlike most food-borne pathogens, it is able to multiply. It has been suggested that plant oils, together with refrigeration may help to reduce the growth of *L. monocytogenes*.

0 9 . **4** What conclusions can be drawn about the effectiveness of using plant oils with refrigeration to reduce food-borne infections caused by *L. monocytogenes*?

[3 marks]

Question 9 continues on the next page

0 9 . **5** Plant oils are hydrophobic and can cross the cell-surface membrane of the bacterium. The low temperature of 4 °C can slow the rate of entry of plant oils into the cells.

Suggest how the low temperature slows the rate of entry.

[1 mark]

10

1 0

1

Describe the appearance and behaviour of chromosomes during mitosis.

[5 marks]

[Extra space] _____

Question 10 continues on the next page

1 0 . 2 Describe and explain the processes that occur during meiosis that increase genetic variation.

[5 marks]

[Extra space] _____

10

END OF QUESTIONS

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